

High-Energy Backgrounds in the SNO Detector

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The Sudbury Neutrino Observatory (SNO) is a large volume water Čerenkov detector, with a central target of 1000 tonnes D_2O . Located 6800 feet below the Earth's surface in Creighton Mine #9, near Sudbury, ON, the experiment has been designed to study the interactions of solar neutrinos. One of backgrounds to the neutrino signal is high-energy γ -rays coming from outside of the D_2O volume. High energy γ -rays can be produced by (n,γ) interactions. The fast neutrons involved in these reactions fast neutrons arise from (α,n) in the U and Th and from the spontaneous fission of U and Th. Another major source of high energy γ -rays is the α -induced gammas, from (α,γ) , $(\alpha,n\gamma)$ and $(\alpha,p\gamma)$ reactions [1]. Here α s come from the Th and U decay chains. Of particular concern here are the α reactions on Al which can produce gammas up to 9 MeV.

These reactions can occur both in the rock, in the PMT glass and the PMT Support Structure (PSUP). The high-energy γ -rays which are emitted from the rock wall will preferentially appear near the equator of the SNO detector due to the cylindrical shape of the SNO cavity. The flux of high energy γ -rays coming from the PSUP and from the PMT glass will appear from all directions in the detector.

The high energy gammas are attenuated by the H_2O , but a small number will reach the D_2O . Due the reconstruction resolution, some of the γ -rays at large radii can misreconstruct into the D_2O , where they will form a background to the neutrino analysis.

In order to estimate the high-energy γ -ray contamination inside the neutrino data, the SNO ^{16}N source can be used. The ^{16}N source [2], which was designed and built at LBNL, provides a tagged 6.13 MeV γ -ray. Several runs have been performed with the ^{16}N source near the edge of the detector to simulate a flux of high-energy γ -rays. In the ^{16}N data one can select inward-pointing events inside a shell at large radii and above an energy threshold. The number of ^{16}N source events in the H_2O shell and the number of ^{16}N events which reconstruct in the fiducial volume of the D_2O yield a value of η , which is the number of events in the fiducial volume over the number of events in the shell in the H_2O . (See the schematic in Figure 1.) By looking at the number of events in the solar neutrino data in the H_2O shell and scaling it by

η , one can determine the number of high-energy γ -rays which are present in the neutrino data inside the fiducial volume. Preliminary measurements indicate that there should be less than 10 events per live year in the neutrino dataset inside the fiducial volume and above the energy threshold.

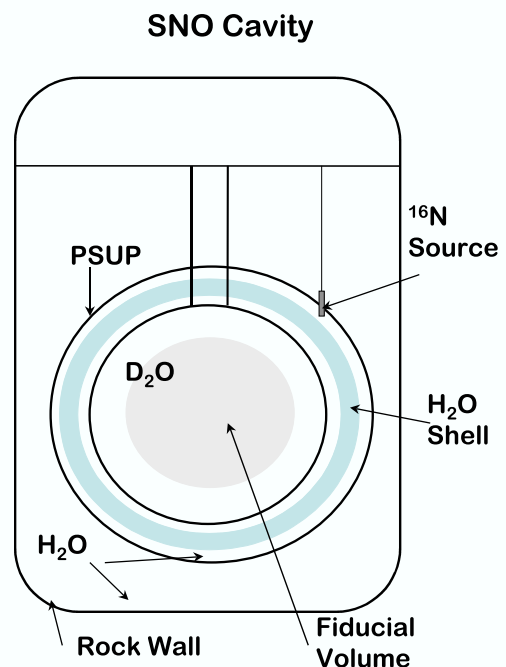


FIG. 1: A schematic showing the SNO cavity, the fiducial volume, and the high-radius shell used with the ^{16}N source for estimating the high-energy γ -ray contamination.

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- [1] Heaton, R.K. et al., *Nuc. Inst. Meth. A*, **364**, (1995) 317
 - [2] Dragowsky, M.R. et. al., *Nucl. Intrs. Meth. A*, **481**, (2002) 284-296